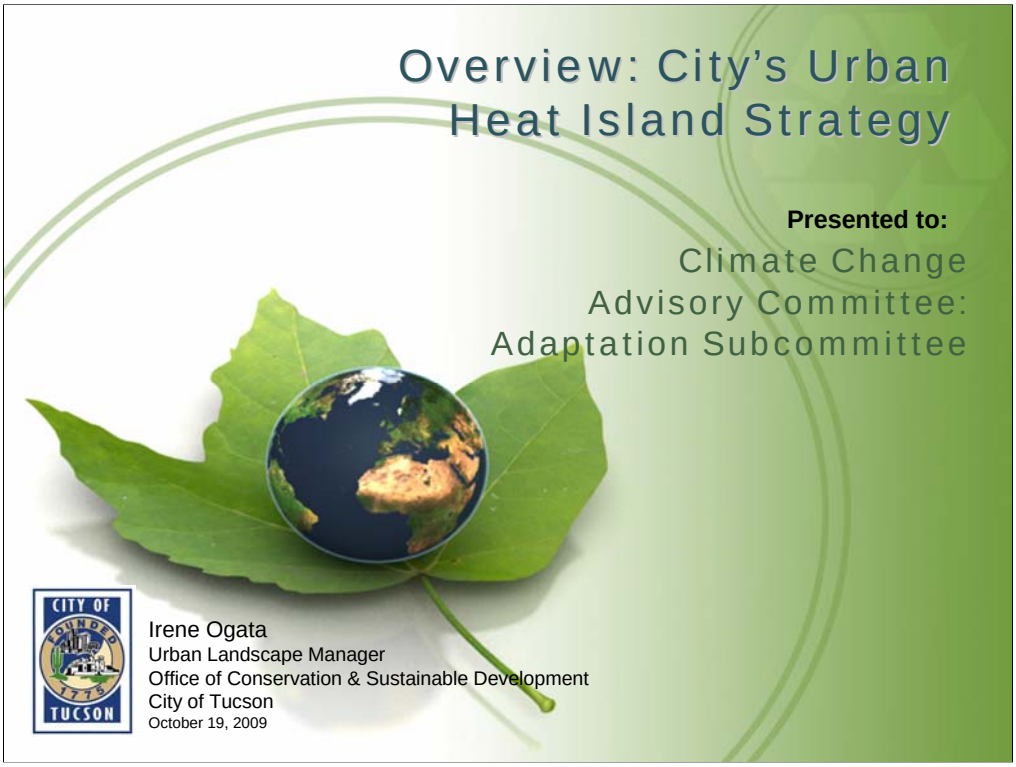


3 basic goals:

1.Health - human

2.Health – environmental/urban health

3.Health – balancing anthropogenic activities in the Sonoran Desert

Acknowledge the importance of sun

For photosynthesis

Oxygen production

Plant production which are a food source for bugs, animals and people

Vit. D which we humans absorb through our skin

Alternative energy production . . .

We can all agree this region is one of the richest deserts in terms of diversity

We know populations are moving to urban centers – Tucson is growing

In the South West we have 211 average sunny days

In Arizona we average 100-145 days of 100^0C or greater midday temperatures

•The phenomena of urban heat islands has been studied for 40+ years now by National Oceanic Atmospheric Agency (NOAA), NASA, Berkeley Lawrence Laboratory in CA and Oakridge Laboratory in Tennessee.

•EPA has had a Heat Island Reduction Initiative for about 10+ year; prior to the HIRI, The Dept of Energy had a Cool Communities program.

•City of Tucson was one of 9 Cool Communities in the nation – largely due to Trees for Tucson and its efforts in planting and promoting trees through the region.

The UHI phenomena

About cities creating more hot surfaces –

Pavement

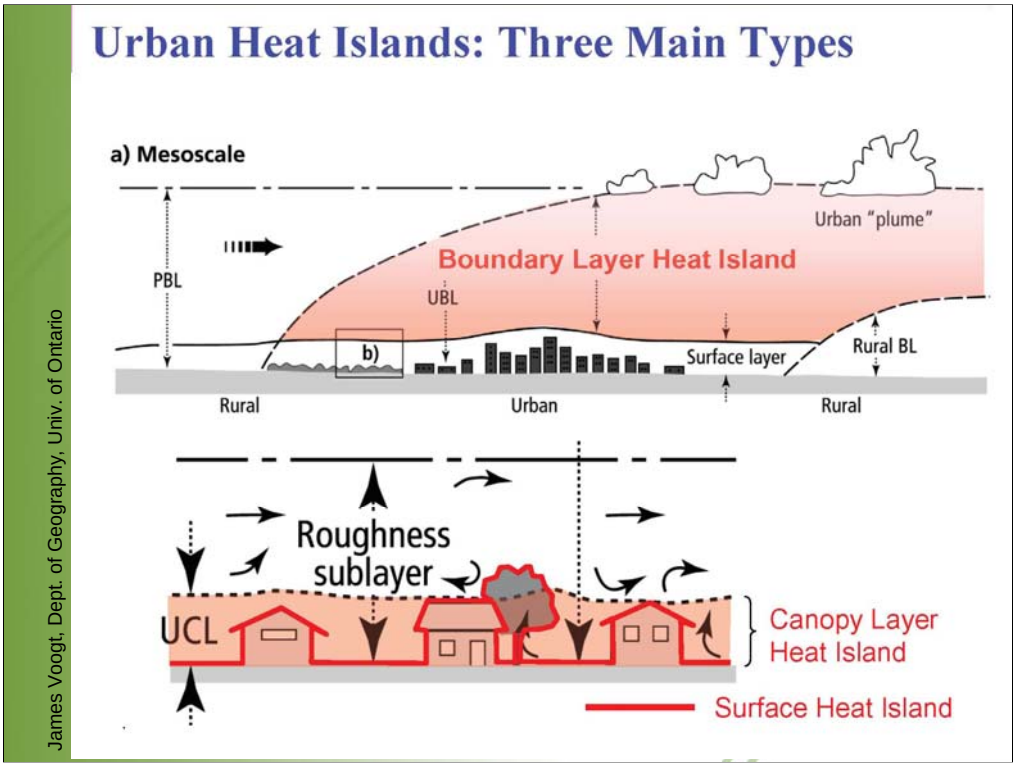
Rooftops

Building walls

These elements also contribute to CO_2 production

Buildings contribute approximately 40% of CO2 from use of concrete (1 ton concrete production = 1 ton CO_2 production)

Cars contribute approximate 30% carbon emission



When talking about Urban Heat Islands (UHI) – basically 3 boundaries of measurement

Need to also understand areas in which the temperature is being measured.

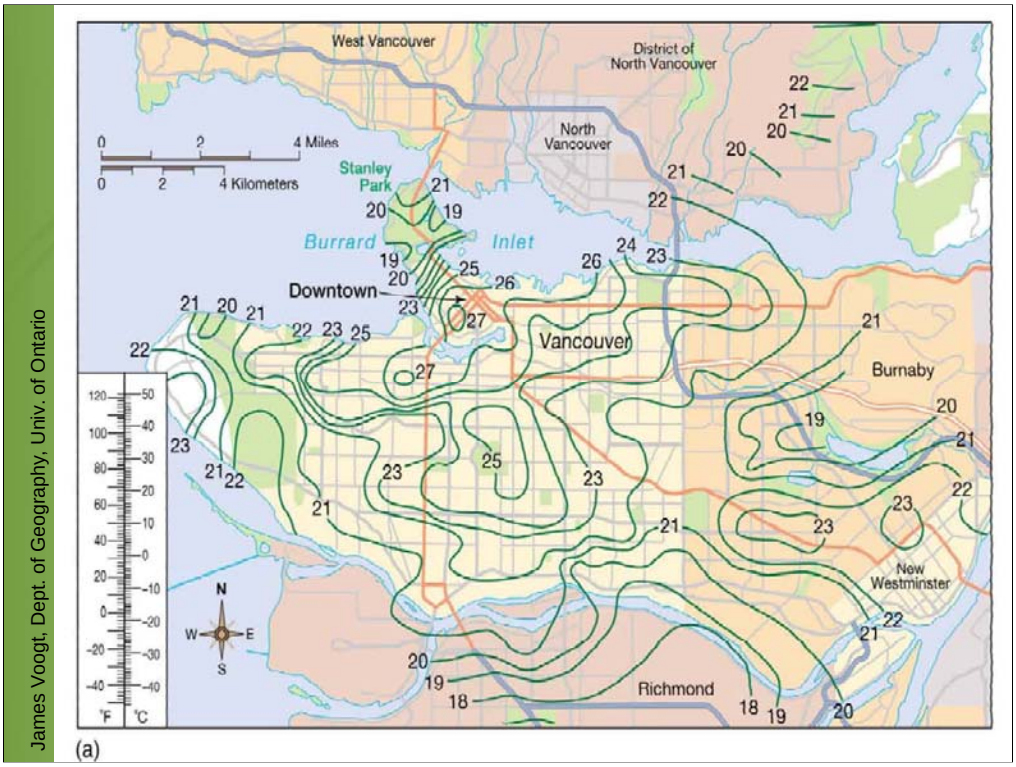
In general when referencing UHI,

The areas of interest are the surface Heat Island and Canopy Layer Heat Island.

The upper Boundary Layer Heat Island is the link between UHI and global climate change.

The lower layers are the about us and health.

If we begin to map canopy layer air temperature, isotherms, readings over cities ---

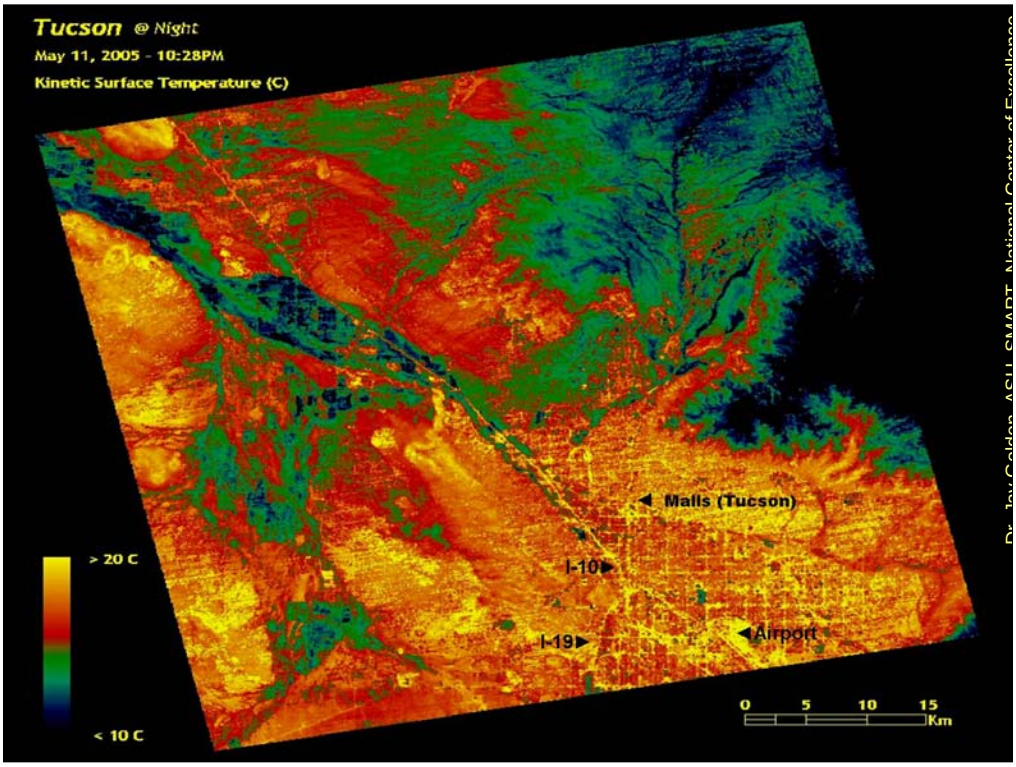


Mapping of isotherms (canopy layer)

Isotherms of Vancouver

We begin to see the hot spots, the islands of heat generated within the city

Reminder: surface temperatures can be 50º C – 90º C hotter than the canopy air temperature



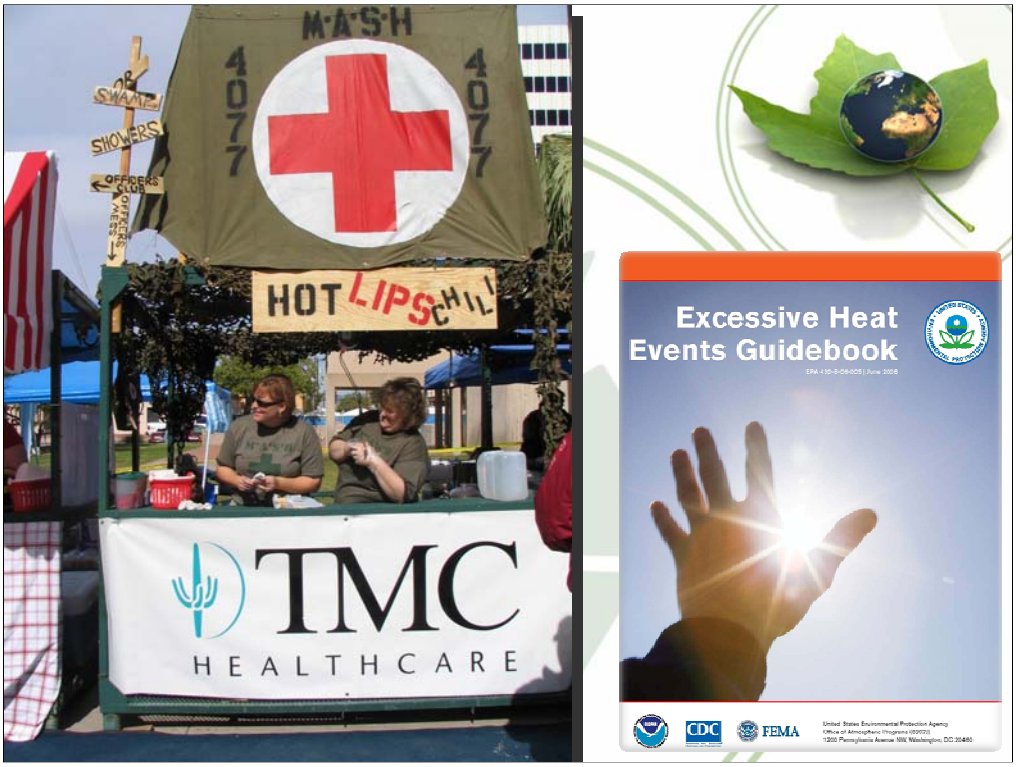
These areas can also be seen by infrared satellite photography

Temperature scale: yellow hottest – blue coolest

Easy to see I-10 & I-19 and the airport

20^{o}C greater than 68^{o}F
10^{o}C less than 50^{o}F

Large green dot = Reid Park – the City's largest regional park



Why is this temperature elevation bad. Why be concerned by Urban Heat Islands?

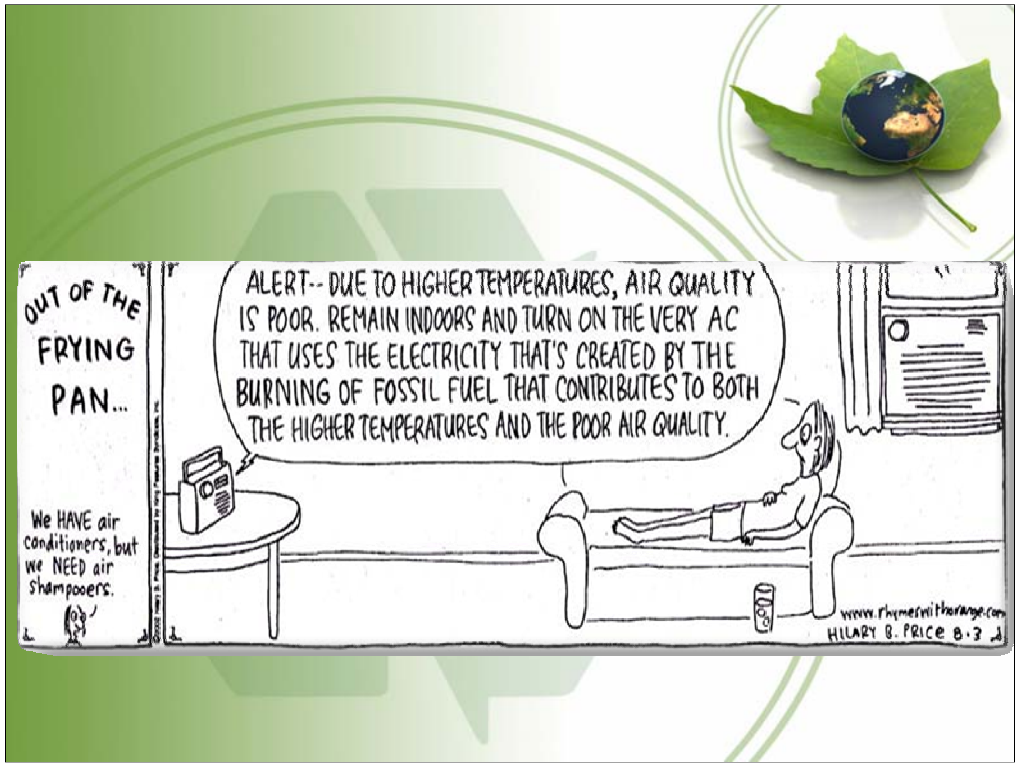
For vulnerable populations in cities, usually the elderly and young, but now also those with various medical problems, such as chronic respiratory disease, obesity, heart conditions, excessive heat takes it toll on the human system.

Heat distress can lead to heat stroke and eventually death

In 1998, Europe had over 11,000 heat related deaths

In 1995, Chicago heat wave resulted in 700 heat related deaths.

In 2003, Paris had 15,000 heat related deaths.



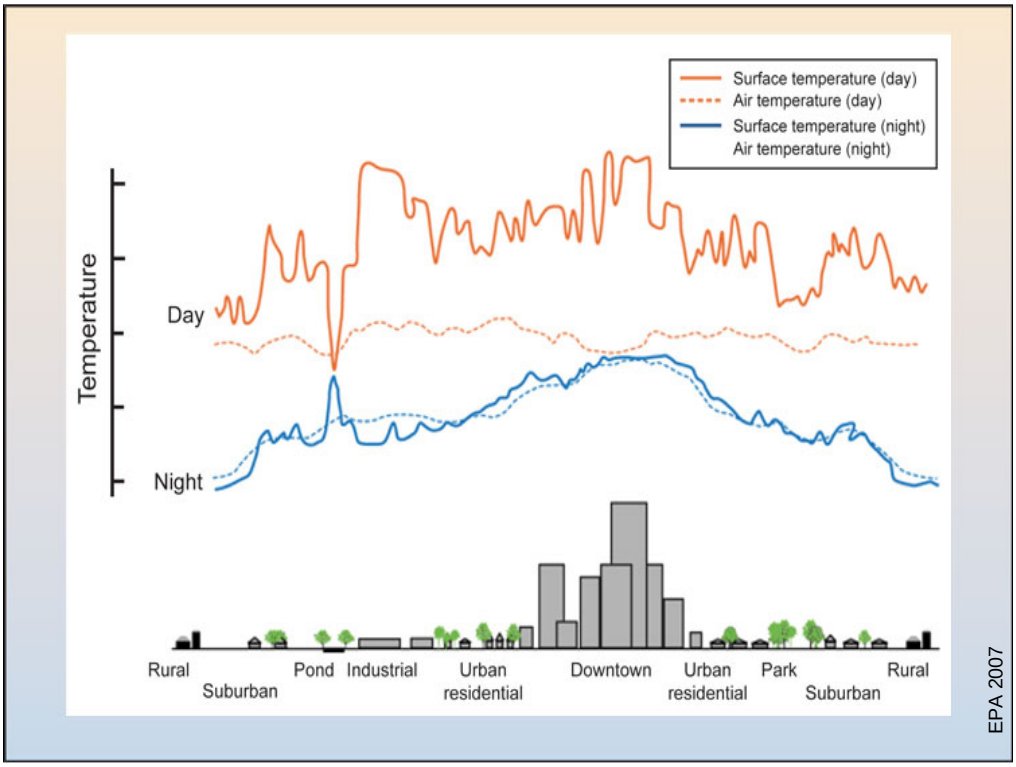
Temperature & air quality alerts in cities

Advise vulnerable populations to stay inside to keep cool;

But as this cartoon illustrates – a catch 22

by staying inside and turning up the cooling system – the energy used by either AC or cooler or fan ---

is electricity from a generating plant that is adding more CO2 into the air, creating greater heat in the upper boundary layer heat island.



In the southwest, during the day – it's hot, but typically cools down at night,

Now, in urban areas, the heat event is both during the day and the night

As the red line shows, during the day, surface temperatures can be 50^{o} to 90^{o} higher than air temperature.

At night, in the rural and suburban areas, the night temperature drops – illustrated by the difference in the blue and red dotted lines,

But in the urban area, there is no significant drop in the air temperature.

In the southwest, our cities are remaining just as hot at night as during the day.

This in turn causes us to keep our mechanical cooling systems on all day – no rest for the electric generating plants

The 3 mitigative approaches has been to address

Roofs

Paving

Trees

Roofs & Paving is about reflective surface

In the US within the last 20-25 years, Paving has also been about permeability

And within the last 10 years, roofs has also been about capturing water.

We know a lot about the value of trees and UHI.

Trees provide shade – temperature under a shady tree can be 10^{o} – 12^{o} cooler

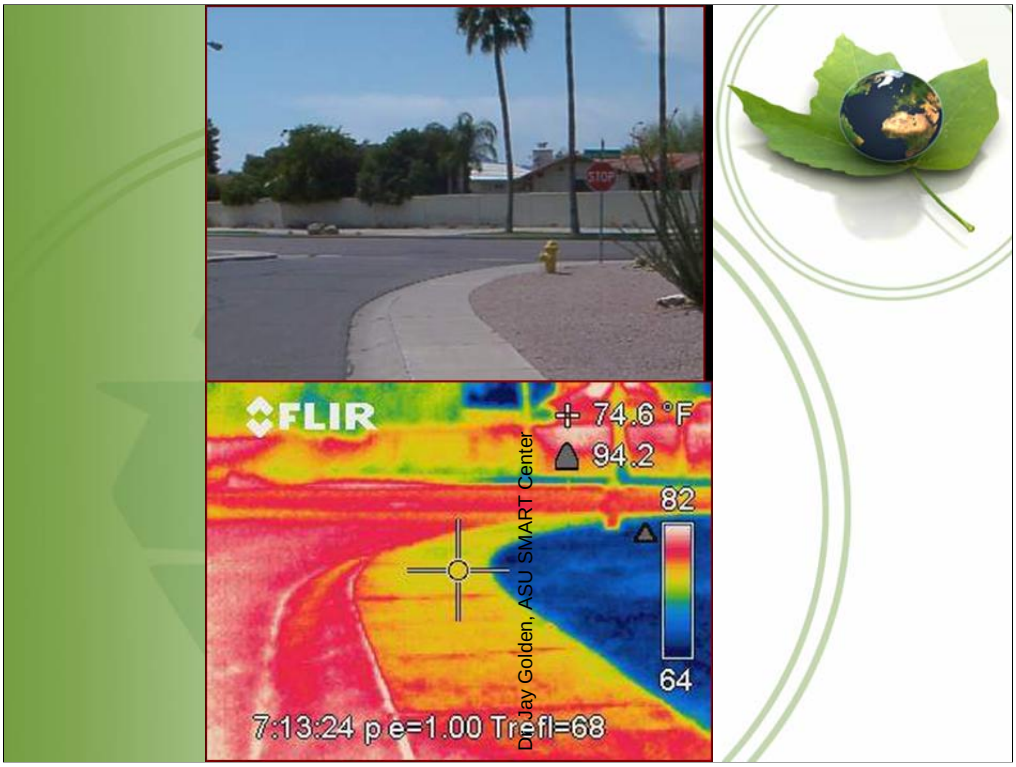
Study out of UC Davis shows shade from trees can also extend the lifecycle of asphalt.

A different study out of UC Davis also shows tree absorb pollutants from cars, assisting to clean the air.

Tree also provide oxygen and sequester carbon dioxide

And have been shown to Increase property value by 3-7%,

Commercial areas with trees attract more shoppers who are willing to spent 11% more for goods and services.



Roofs and pavement are the largest causes of UHI and tackling those 2 issues are also the most difficult.

Paving and parking lots comprise approximately 40% of urban surfaces.

As this near infrared photograph illustrates, at 7 p.m. the road, sidewalk, walls and roofs are the hottest surface areas in the landscape.

The decomposed area and trees are cooler.

There are several cooling approaches suggested by EPA and also approved points by USGB.

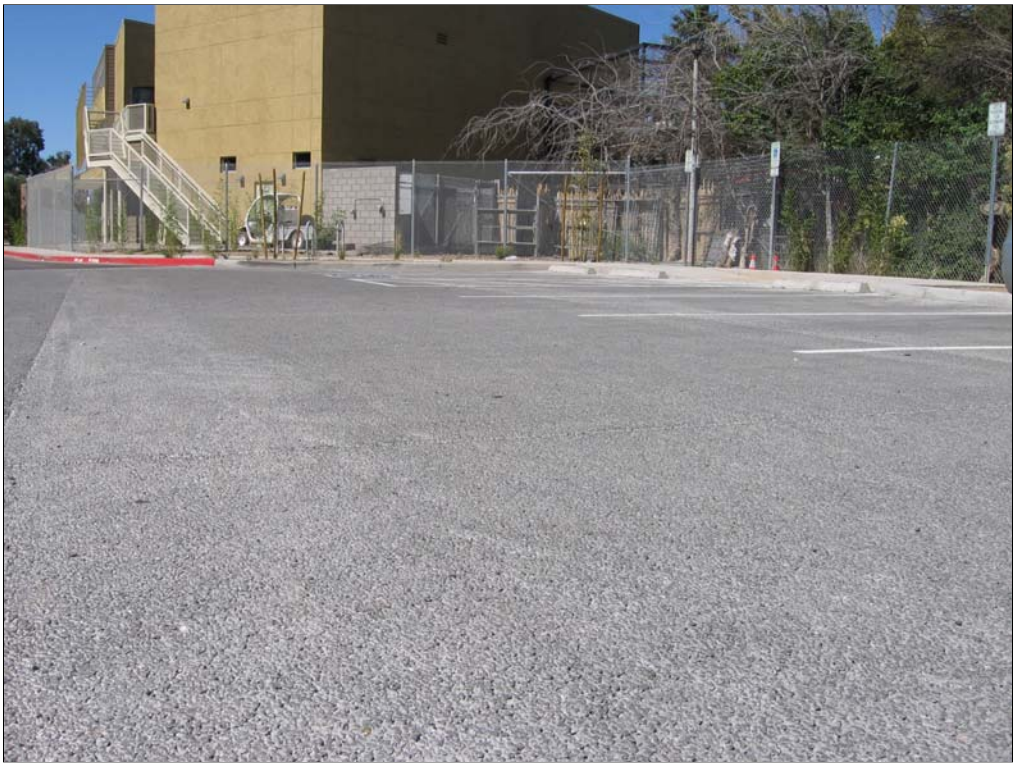
Pervious asphalt and porous concrete are slowing making their way out west.

They have been utilized for over 20 years in the east. ASU's SMART Center has been testing porous concrete for its durability and maintenance.

Porosity of the concrete creates air pockets that allow rainwater to pass through, and also assists in cooling the material. White topping of pavement surfaces is also being tested by ASU's SMART Center.

Porous concrete is largely utilized in parking lots. Phoenix poured a demonstration parking lot at the ASU Museum of Art 3 years ago.

City of Tucson poured a porous concrete parking lot at the Reid Park Zoo's Learning Center.



Porous concrete is largely utilized in parking lots. Phoenix poured a demonstration parking lot at the ASU Museum of Art 3 years ago.

This is City of Tucson Reid Park Zoo's Learning Center porous concrete parking.

Back east in cold climate areas, I've heard attorney's for big box developments have encouraged porous paving materials – no water puddles to ice over and present liability from slipping in parking lots.

Arizona has a Cool Roof Council.

Roofs have energy ratings and cool coatings have shown to increase reflectivity and less heat absorption.

City of Tucson applied cool roof coating on the Price Service center over 10 years ago. The roof topping cut electrical use by 50%.

You'd think it a no brainer

to develop an ordinance requiring all buildings to utilize cool roof coatings. Scottdale attempted such an ordinance, but later removed it off the books due to complaints by citizens of the glaring whiteness.

Need to be aware of potential unintended consequences – adjacency of low and high building heights, residential developments with sloped roof.

The other type of roofing making its way to the southwest are green or living roofs.

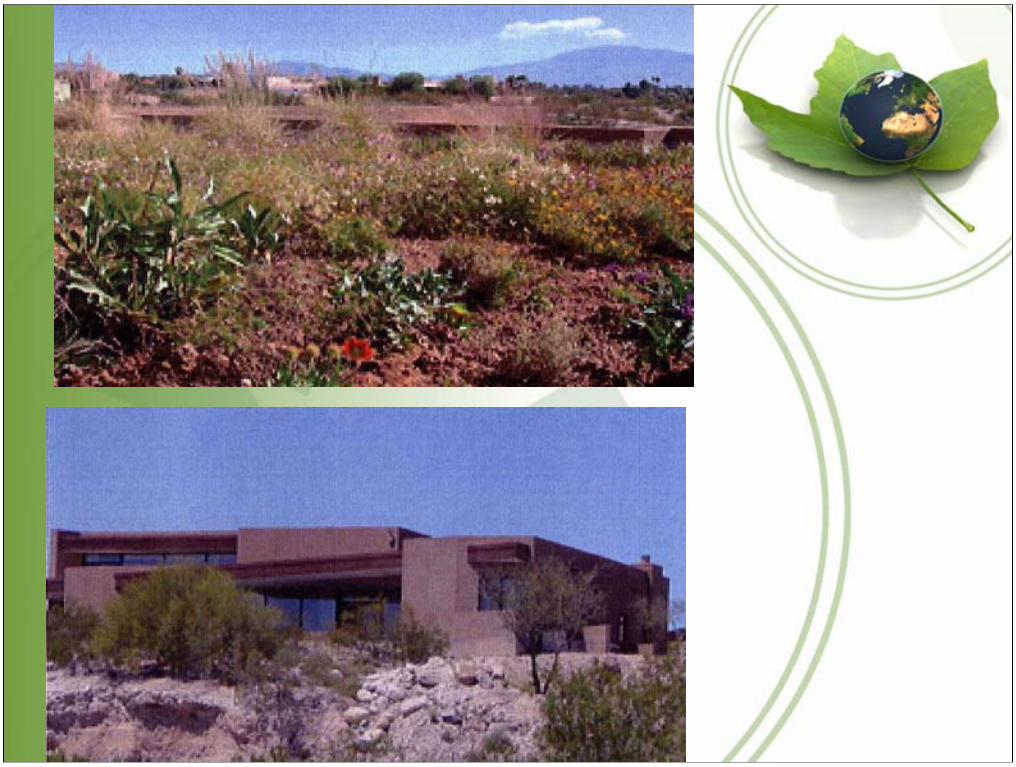
Utilized in Europe, especially Germany for decades – some century old buildings.

Construction of green roofs has been undergoing ASTO standardization. I first heard of this about 3 years ago. Not sure where they are in the standardization process.

There are basically 2 types.

One Less than 12 inches, intensive = some recent local applications

and the other over 12 inches, extensive = traditionally the overstory gardens



This one of the first residential intensive green roofs in the City of Tucson – installed 3 years ago.

This is an intensive roof.

An extensive example in Tucson has been around since the construction of City Hall and the underground parking garage – La Placita Plaza

Trees and vegetation are generally in planter boxes.

City of Tempe installed one of the first public facilities with a green roof – the Tempe Transit Center

Materials used were low water use, drought tolerant plant materials. Not all are native.

One of the largest green roofs is the California Academy of Science in Golden Gate Park in San Francisco – over 3 acres of native California ground covers.

Not only are green roofs seen as cooling the air temperature but also as another eco-environment.

The California Academy of Science is monitoring the butterfly and insect life that utilize the rooftop.

Paul Kephart, an ecologist, owner of Rana Creek, installed the CA Academy of Science roof. He was speaker 2 years ago at the City's UHI workshop.

Relayed an anecdotal observation: he's completed several living roofs and scatter wildflower seeds. One of the wildflowers is a nectar source for a species of endangered butterfly – he's seen them feeding on the roofs.

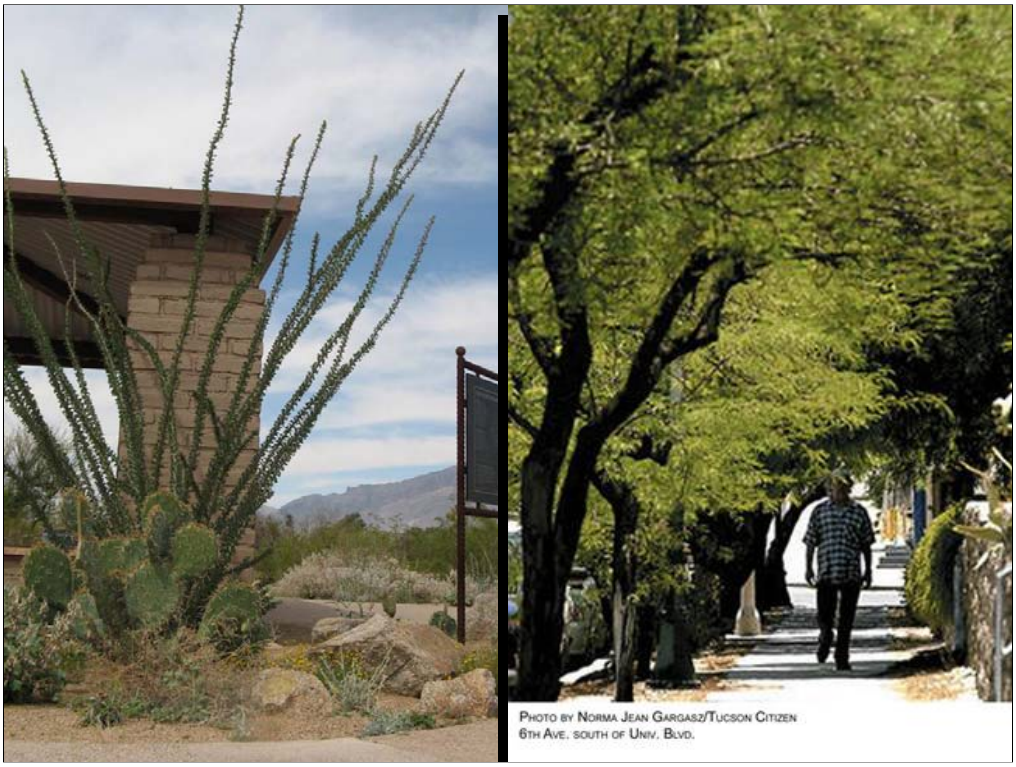
Could this become the new corridor for the species?

One of the easiest low hanging fruits to mitigate UHI is

Planting trees.

It’s a feel good activity to plant trees –

And trees provide to ourselves both physical and mental benefits.



We do need to be considerate of what types of trees we plant.

Native is better adapted to this region in terms of water use and climate tolerance.

But when we think of sense of place and historical ties, historic landscapes and introduced species also need to be considered.

Core areas of the cities are historically significant, with equally historically significant landscapes --- these tend to be non-native species.

Also need to be aware of shade patterns created by trees.

Native plant materials tend to have feathery shade patterns.

Where as non-native, but low water use trees can have denser shade patterns.

And palms are in the grass family – they are not considered shade trees

Long term ecological studies are also revealing environmental justices issues within urban neighborhoods.

Sociology researchers such as Frances Kuo at the Univ. of Il at Urbana and Sharon Harlan at ASU

Are revealing the environmental inequities between areas populated by lower income areas and higher income areas.

Frances Kuo's studies, about 5 years ago, in urban housing project areas in the City of Chicago, illustrated neighborhoods with street trees and green neighborhood parks, school age children had greater memory retention and better study habits.

This prompted Mayor Daley to prioritize planting of street trees in low income neighborhoods.

Sharon Harlan's research, about 4 years ago in the Phoenix area, revealed neighborhoods with greater income were cooler than lower income neighborhoods.

Last year Sharon presented her research findings the City's UHI workshop:

Her sound bite: for every $10,000, you can buy ½ degree of coolness.

This was largely due to Higher income neighborhoods had more trees and greenery than low income neighborhoods.

(1) Before: 1996

As Joni Mitchell's 1970 Big Yellow Taxi song stated "you don't know what you lost till its gone"

Tore down Paradise and put up a parking lot"

In essence creating a paradise of urban heat islands.

Well, we know what we lost, and we need to work together . . .

Entrance to City Hall, 2007

The City tore down the entrance parking lot and replaced it with

Sunset Park,

entrance to City Hall today.

Only 2 parking spaces were lost

We need to take out more parking lots and replace with Paradise.

Trees,

porous paving and

green roofs,

along with water harvesting principles,

are also seen as part of best practices for storm water control.

Imagine

A GREAT DESERT CITY

We all need to work together to find the balance between anthropogenic urban living and not destroying the diverse desert ecosystem we live in.

This means not only advocating for cooler urban construction practices,

but also advocating for the maintenance and operation of these spaces.

Everything in the urban environment is designed and constructed.

Those areas we consider to be natural – the watercourses – are designed to be maintained in some fashion.

Maintenance and operation is part of design.

Urban Heat Island Mitigation Strategies

Trees

Roofs

Paving


Imagine
A Great Desert City
Irene.ogata@tucsonaz.gov